What is Claimed:

1. A masking aperture for an illumination system to provide controlled illumination of a photomask with two dimensional features comprising:

a translucent substrate;

a half-tone dithered image on the substrate, said half-tone dithered image comprising an array of pixels for generating a continuous illumination intensity pattern on the photomask with illumination intensity at any location controlled by the half-tone dithered image.

2. The masking aperture of claim 1 wherein each pixel is a clear or opaque type, said clear and opaque pixels for respectively passing and blocking incident light, wherein the number, size, and type of the pixels are chosen in accordance with:

(a) the wavelength of light used to illuminate the photomask, and

(b) the size and shape of the features of the photomask,

3. The masking aperture of claim 1 wherein the half-tone dithered image comprises an array of diffraction elements and each diffraction element is a dithered image of clear or opaque pixels.

4. The masking aperture of claim 3 wherein each diffraction element comprises an n x n dithered matrix of pixels, the intensity of each element is defined by the number and type of pixels in its dithered matrix and wherein the pixels in each matrix are dithered to avoid artifacts.

5. The masking aperture of claim 3 wherein the relative intensity of each element is defined by a recursion relationship where:

$$D^n = \begin{vmatrix} 4D^{n/2} + D_{00}^2 U^{n/2} & 4D^{n/2} + D_{01}^2 U^{n/2} \\ 4D^{n/2} + D_{10}^2 U^{n/2} & 4D^{n/2} + D_{11}^2 U^{n/2} \end{vmatrix}$$

where:

21. The masking aperture of claim 8 wherein the zones comprise an annular ring and one or more zones with shapes selected from the group of shapes consisting of square, elliptical, ring, square ring, circular ring and combinations thereof.

22. A method for controlling on-axis and off-axis illumination of a photomask comprising the steps of:

directing a beam of light of a selected wavelength toward a pupil of an illumination system;

passing the beam of light through a fly's eye lens located near the pupil;

diffracting the light through a masking aperture having a half tone diffraction pattern of dithered pixels patterned for distributing the light into two or more zones.

23. The method of claim 22 wherein said half-tone dithered image comprises an array of pixels, each pixel of a clear or opaque type and of the same size, said clear and opaque pixels for respectively passing and blocking incident light, wherein the number, size, and type of the pixels are chosen in accordance with:

(a) the wavelength of light used to illuminate the photomask, and

(b) the size and shape of the features of the photomask, for generating a continuous illumination intensity pattern on the photomask with illumination intensity at any location controlled by the half-tone dithered image.

24. The masking aperture of claim 23 wherein the half-tone dithered image comprises an array of diffraction elements and each diffraction element is a dithered image of clear or opaque pixels.

25. The method of claim 24 wherein each diffraction element comprise an n x n dithered matrix of pixels, the intensity of each element is defined by the number and type of pixels in its dithered matrix and wherein the pixels in each matrix are dithered to avoid artifacts.

26. The method of claim 24 wherein the relative intensity of each subpixel is defined by a recursion relationship where:

$$D^n = \begin{vmatrix} 4D^{n/2} + D_{00}^2 U^{n/2} & 4D^{n/2} + D_{01}^2 U^{n/2} \\ 4D^{n/2} + D_{10}^2 U^{n/2} & 4D^{n/2} + D_{11}^2 U^{n/2} \end{vmatrix}$$

where:

$$U^n = \begin{vmatrix} 1 & 1 & \dots & 1 \\ 1 & & & \\ \cdot & & & \\ \cdot & & & \\ \cdot & & & \\ 1 & & & \end{vmatrix}$$

27. The method of claim 26 wherein the matrix of pixels comprises an 8 x 8 matrix and the relative intensity, D8, comprises:

$$D^8 = \begin{vmatrix} 0 & 32 & 8 & 40 & 2 & 34 & 10 & 42 \\ 48 & 16 & 56 & 24 & 50 & 18 & 58 & 26 \\ 12 & 44 & 4 & 36 & 14 & 46 & 6 & 38 \\ 60 & 28 & 52 & 20 & 62 & 30 & 54 & 22 \\ 3 & 35 & 11 & 43 & 1 & 33 & 9 & 41 \\ 51 & 19 & 59 & 27 & 49 & 17 & 57 & 25 \\ 15 & 47 & 7 & 39 & 13 & 45 & 5 & 37 \\ 63 & 31 & 55 & 23 & 61 & 29 & 53 & 21 \end{vmatrix}$$

28. The method of claim 25 wherein the matrix of diffracting elements is selected from the group consisting of 2 x 2, 4 x 4, 8 x 8, 16 x 16, 32 x 32 and 64 x 64.

29. The method of claim 22 further comprising the step of forming two or more zones.

30. The method of claim 29 wherein the zones are arranged symmetrically about the center of the masking aperture.

where:

$$U^n = \begin{vmatrix} 1 & 1 & \dots & 1 \\ 1 & & & \\ \cdot & & & \\ \cdot & & & \\ \cdot & & & \\ 1 & & & \end{vmatrix}$$

6. The masking aperture of claim 5 wherein the matrix of pixels of each element comprises an 8 x 8 matrix and the relative intensity, D8, comprises :

$$D^8 = \begin{vmatrix} 0 & 32 & 8 & 40 & 2 & 34 & 10 & 42 \\ 48 & 16 & 56 & 24 & 50 & 18 & 58 & 26 \\ 12 & 44 & 4 & 36 & 14 & 46 & 6 & 38 \\ 60 & 28 & 52 & 20 & 62 & 30 & 54 & 22 \\ 3 & 35 & 11 & 43 & 1 & 33 & 9 & 41 \\ 51 & 19 & 59 & 27 & 49 & 17 & 57 & 25 \\ 15 & 47 & 7 & 39 & 13 & 45 & 5 & 37 \\ 63 & 31 & 55 & 23 & 61 & 29 & 53 & 21 \end{vmatrix}$$

7. The masking aperture of claim 4 wherein the matrix of the diffracting elements is selected from the group consisting of 2 x 2, 4 x 4, 8 x 8, 16 x 16, 32 x 32 and 64 x 65.

8. The masking aperture of claim 1 wherein the elements generate one or more zones of controlled intensity.

9. The masking aperture of claim 8 wherein the zones are symmetrical about the center of the masking aperture.

10. The masking aperture of claim 9 wherein the zones have one shape selected from the group consisting of circles, squares, rectangles, and ellipses, rings, circular rings, square rings, or combinations thereof.

11. The masking aperture of claim 10 wherein the selected shape is a stepped square.

12. The masking aperture of claim 10 wherein the selected shape is an ellipse and the major axis of each ellipse is aligned at a 45-degree angle with respect to the center of the masking aperture.

13. The masking aperture of claim 1 comprising one or more zones arranged symmetrical about the center of the masking aperture.

14. The masking aperture of claim 1 comprising one or more zones arranged asymmetrical about the center of the masking aperture.

15. A masking aperture for an illumination system to provide controlled illumination of a photomask with two dimensional features, comprising:

a translucent substrate;

an array of diffraction elements on the substrate and each diffraction element comprising a half-tone dithered image of clear and opaque pixels;

each half-tone image comprising an array of pixels, each pixel of a clear or opaque type for respectively passing or blocking incident light, wherein the number, size, and type of the pixels are chosen in accordance with:

(a) the wavelength of light used to illuminate the photomask, and

(b) the size and shape of the features of the photomask, for generating a continuous illumination intensity pattern on the photomask with illumination intensity at any location controlled by the half-tone dithered image.

16. The masking aperture of claim 8 comprising a zone with a square ring.

17. The masking aperture of claim 16 wherein the zone comprises four translucent slots.

18. The masking aperture of claim 16 wherein the intensity in the square ring varies from 0 % to 100 %.

19. The masking aperture of claim 16 wherein the intensity outside the square ring varies from 0% to 99%.

20. The masking aperture of claim 16 wherein the square ring is combined with one or more zones having a shape selected from the group consisting of square, elliptical, ring, square ring, circular ring, or combinations thereof.

31. The method of claim 29 wherein the zones are arranged asymmetrically about the center of the masking aperture.

32. The method of claim 29 the zones have one shape selected from the group consisting of circles, squares, rectangles, ellipses, rings, circular rings, square rings and combinations thereof.

33. The method of claim 29 wherein the selected shape is a stepped square.

34. The method of claim 29 wherein the zone(s) is shaped in an ellipse and the major axis of each ellipse is aligned at a 45 degree angle with respect to the center of the masking aperture.

35. An illumination system comprising:

a light source for emitting light of selected wavelength(s) in an optical path toward a pupil,

means for shaping the light from the source into a shaped illumination pattern having one or more zones where the intensity of the light in the zones varies to produce a shaped illumination pattern for each zones;

means for optically integrating light incident on the pupil;

a square shaped aperture disposed proximate the pupil for squaring the edges of the shaped illumination distribution pattern; and

optical means for combining the shaped illumination to illuminate a photomask.

36. The illumination system of claim 35 wherein the means for shaping the light comprises a plurality of masking apertures.

37. The illumination system of claim 36 wherein one of the masking apertures comprises an opaque plate with one or more apertures.

38. The illumination system of claim 37 wherein one of the masking apertures comprises a translucent plate with a central obscuration.

39. The illumination system of claim 38 wherein the obscuration is circular or square.

40. The illumination system of claim 35 wherein the means for optically integrating light is a fly's eye lens.

41. The illumination system of claim 35 wherein the square shaped aperture comprises a translucent substrate and a square pattern or a metal plate with a square aperture.

42. The illumination system of claim 35 wherein the shaped illumination pattern has a shape selected from the group consisting of round, square, and elliptical shapes.

43. The illumination system of claim 42 wherein the means for shaping the light comprises one or more diffractive optical elements.

44. The illumination system of claim 42 wherein the means for shaping the light from the source comprises one or more beam splitters located between the source of light and the pupil.

45. The illumination system of claim 44 wherein the optical means for combining the shaped illumination pattern comprises a refractive element for each beam.

46. The illumination system of claim 35 wherein the means for shaping an illumination pattern comprises a masking aperture comprising:

a translucent substrate;

a half-tone dithered image on the substrate, said half-tone dithered image comprising an array of pixels, each pixel of a clear or opaque type and of the same size, said clear and opaque pixels for respectively passing and blocking incident light, wherein the number, size, and type of the pixels are chosen in accordance with:

(a) the wavelength of light used to illuminate the photomask, and

(b) the size and shape of the features of the photomask, for generating a continuous illumination intensity pattern on the photomask with illumination

intensity at any location controlled by the half-tone dithered image.

47. The illumination system of claim 46 wherein the half-tone dithered image comprises an array of diffraction elements and each diffraction element is a dither image of clear or opaque pixels.

48. The illumination system of claim 46 wherein the square aperture is formed the same as the dithered image.

49. The illumination system of claim 47 wherein each diffraction element pixel comprises an n x n dithered matrix of pixels, the intensity of each element is defined by the number and type of pixels in its dithered matrix and wherein the pixels in each matrix are dithered to avoid artifacts.

50. The illumination system of claim 47 wherein the relative intensity of each subpixel is defined by a recursion relationship where:

$$D^n = \begin{vmatrix} 4D^{n/2} + D_{00}^2 U^{n/2} & 4D^{n/2} + D_{01}^2 U^{n/2} \\ 4D^{n/2} + D_{10}^2 U^{n/2} & 4D^{n/2} + D_{11}^2 U^{n/2} \end{vmatrix}$$

where:

$$U^n = \begin{vmatrix} 1 & 1 & \dots & 1 \\ 1 & & & \\ \cdot & & & \\ \cdot & & & \\ \cdot & & & \\ 1 & & & \end{vmatrix}$$

51. The illumination system of claim 50 wherein the matrix of pixels comprises an 8 x 8 matrix and the relative intensity, D8, comprises :

$$D^8 = \begin{vmatrix} 0 & 32 & 8 & 40 & 2 & 34 & 10 & 42 \\ 48 & 16 & 56 & 24 & 50 & 18 & 58 & 26 \\ 12 & 44 & 4 & 36 & 14 & 46 & 6 & 38 \\ 60 & 28 & 52 & 20 & 62 & 30 & 54 & 22 \\ 3 & 35 & 11 & 43 & 1 & 33 & 9 & 41 \\ 51 & 19 & 59 & 27 & 49 & 17 & 57 & 25 \\ 15 & 47 & 7 & 39 & 13 & 45 & 5 & 37 \\ 63 & 31 & 55 & 23 & 61 & 29 & 53 & 21 \end{vmatrix}$$

52. The system of claim 35 wherein the means for optically integrating light on the pupil is a plurality of fly's eye lenses.

53. An illumination system comprising:

a light source for emitting light of selected wavelength(s) in an optical path toward a pupil,

means for shaping the light from the source into a shaped illumination pattern having one or more zones where the intensity of the light in the zones varies to produce a shaped illumination pattern for each zones and wherein the zone is shaped from the group consisting of ellipses, square rings, stepped square rings and combinations thereof;

means for optically integrating light incident on the pupil; and

optical means for combining the shaped illumination to illuminate a photomask.

54. The illumination system of claim 53 further comprising means for shaping the light into additional patterns selected from the group consisting of circles, squares, rectangles and circular rings.

55. A method for controlling on-axis and off-axis illumination of a photomask comprising the steps of:

directing a beam of light of a selected wavelength toward a pupil of an illumination system;

passing the beam of light through a fly's eye lens located near the pupil;

diffracting the light to form a pattern of illumination intensity in one or more

zones wherein each zone has a shape corresponding to shapes selected from the group consisting of ellipses, square rings, stepped squares and combinations thereof.

56. The method of claim 55 further diffracting the light beam to form one or more additional patterns of light intensity selected from the group consisting of circles, squares, rectangles and circular rings.